BELLCOMM, INC.
955 L'ENFANT PLAZA NORTH, S.W. WASHINGTON, D. C. 20024

SUBJECT: GLEP Site Selection Subgroup
Third Meeting - November, 1968
Case 340

DATE: December 19, 1968

FROM: F. El-Baz

ABSTRACT

The third GLEP Site Selection Subgroup meeting was held on November 13-14, 1968 at the Center of Astrogeologic Studies, USGS/Menlo Park. Eighteen participants agreed to recommend to the GLEP that:

1. For the first lunar landing mission, the five prime candidate sites (II P-2, II P-6, II P-8, III P-11 and II P-13) remain unchanged. However, if the landing is to be in an eastern site, II P-6 is preferable to II P-2 for scientific reasons.

2. The candidate sites for the second lunar landing be II P-2, II P-6 (same as first mission) and relocated sites in II P-8, III P-11 and III P-12. If the first landing occurs in an eastern mare, the second mission should be to a western mare and vice versa.

3. The best possible site for the third lunar landing is Censorinus. Other possible candidate sites include five in the Apollo Zone and four outside the Zone.

4. The USGS should prepare the following geologic maps in FY-69: a) relocated sites in II P-8, III P-11 and III P-12 at 1:5,000; b) a 1:25,000 map of III P-12; c) two maps at 1:25,000, one for Censorinus and the other for Rima Bode II (it is argued here that Rima Bode II should be replaced by Littrow which is already on the FY-69 GLEP list of sites); d) completion of the partly finished maps of Tycho (approximately 1:10,000) and of Fra Mauro (approximately 1:150,000); and finally to request base maps (controlled or uncontrolled) from the DoD for future geologic maps of candidate sites for the third and following missions.

5. No new geologic maps be produced specifically to support the LFU and LRV design and trafficability studies. Presently available products should meet the requirements for FY-69.

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MEMORANDUM FOR FILE

I. INTRODUCTION

The Site Selection Subgroup* of the Group for Lunar Exploration Planning (GLEP), held its third general meeting on November 13-14, 1968 at the Center for Astrogeologic Studies, U. S. Geological Survey, Menlo Park. The purpose of the meeting was to discuss candidate sites for the first two Apollo lunar landings and recommend a set of sites to be analyzed and mapped for the third lunar landing mission. Several other items were brought up in the meeting as shown on the agenda (Appendix B).

The meeting was called to order by Noel Hinners (Chairman) who discussed the agenda and posed the problem of limited time available for mapping and site analysis, intimating that sites recommended for processing should be more carefully selected. There was general awareness of the fact that lists of selected sites for any given phase of lunar exploration should be left partly open and liable to change in order to accommodate increased knowledge and future developments in lunar exploration. However, it was apparent that geologic mapping and site analyses must be performed well ahead of a given mission, on a small number of sites, because of the man-years involved.

II. STATUS REPORTS

Don Beattie briefed the participants on the new Bureau of the Budget "mark-up" of proposed NASA Plans and its implications to lunar exploration in general and the "Extended LM Phase" in particular. He itemized requirements for at least 3 geologic maps, in addition to those of the early Apollo sites, for mission planning and trafficability studies for both the LFU and LRV. Hal Masursky indicated that a geologic map of any given site would be equivalent to an Apollo site map as far as production man-hours are concerned.

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*See Appendix A for members and invited participants.

Jim Sasser reviewed the ASSB current plan as compared to the present GLEP plan. The ASSB current plan is as follows:

1st landing: Smooth mare - no ALSEP
2nd landing: Smooth mare - with ALSEP
3rd landing: Relocated site of greater scientific interest - with ALSEP

The currently recommended GLEP plan is shown in Figure 1 (next page). In its more conservative path it is equivalent to the aforementioned ASSB plan. However, it also considers the following possibility:

1st landing: Smooth mare - no ALSEP
2nd landing: Relocated* site in a 2nd mare - with ALSEP
3rd landing: A science site, with ALSEP, either
- within the Apollo Zone
or - outside the Apollo Zone

Jim Sasser continued by defining Set A, B and C sites indicating that the ASSB has accepted the philosophy of Set B biased sites. Don Beattie pointed out that it is quite significant that the ASSB has "recommended that a set of biased sites be the next order of priority for analysis" (see ASSB Minutes - Meeting of September 26, 1968); the implication being that the Subgroup may in fact have an input to the 2nd mission. Jim went on describing the relocated sites at II P-2, II P-6, II P-8, III P-12, and the probable relocated site at II P-13 and indicated that no matter where the desired landing point may be, the site analysis work must be ready prior to submitting a proposed change of sites to the ASSB by the Subgroup or the GLEP. At this point, Noel Hinners posed the question of by whom were the locations of the relocated sites established and whether the Subgroup should have another look at them. It was apparent that there is need to reconsider

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*It is important at this point to define the site description terms as they were used in the meeting: A Biased or Science-biased Site is a candidate Apollo site for the second mission which includes, or lies within "walking distance" from a lunar surface feature of high scientific interest. If it falls within the present prime ellipse, it is a Redesignated Site; if it is wholly or partly outside the ellipse, it is a Relocated Site. A Predesignated Point is any given point within the prime ellipse to which designation is not necessarily based on scientific value, e.g., only for operational reasons.

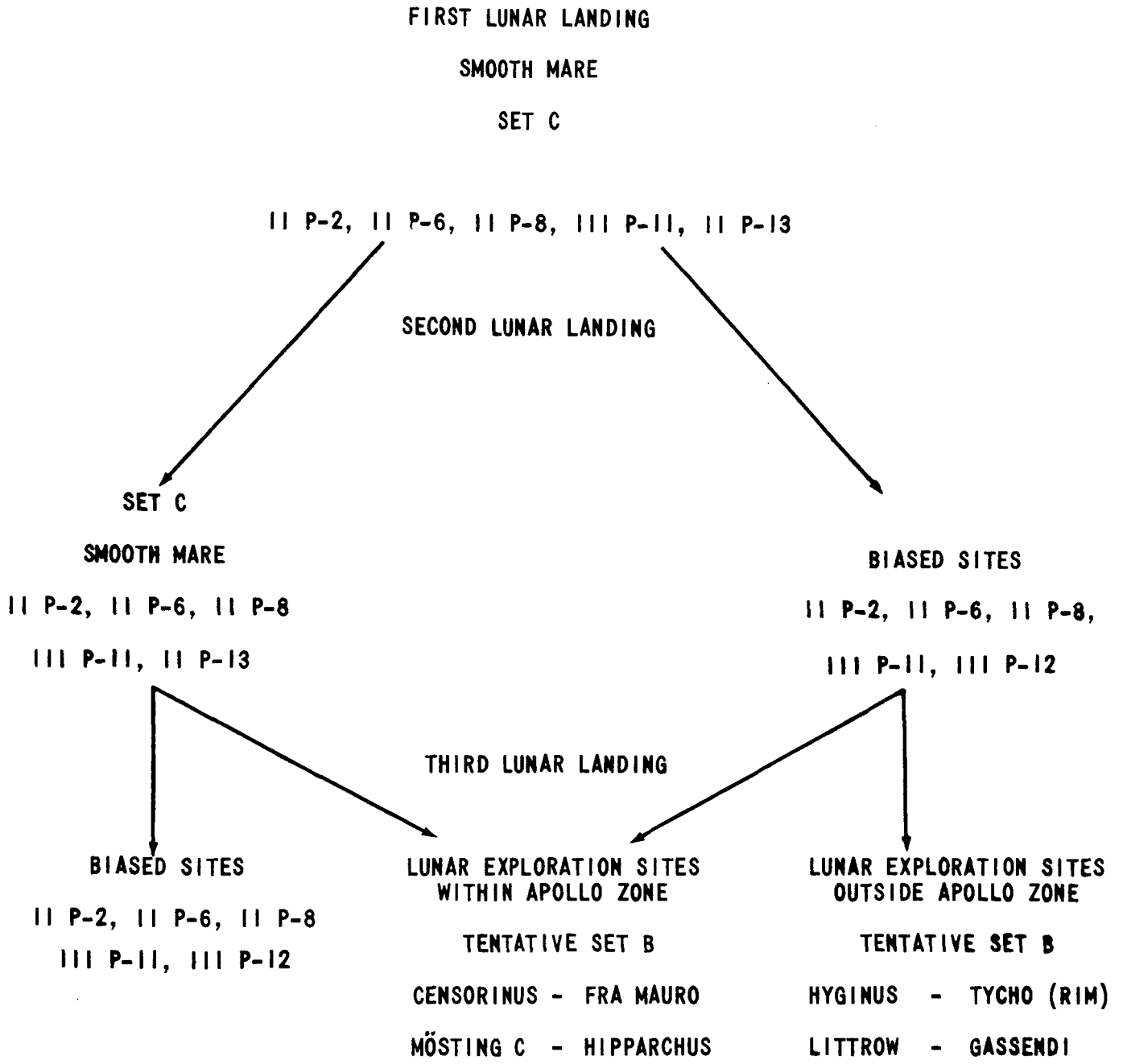

FIGURE I - THE CURRENT GLEP PLAN FOR EARLY APOLLO LUNAR EXPLORATION

these sites and define them in terms of their place in the lunar exploration plan as a whole. This, in fact, was done at this meeting.

Jack Sevier continued the status reports. His briefing dealt with the operational constraints relative to the redesignated sites. He started with the "bad news" including:

- Error sources for descent dispersion analysis
- Relation of position accuracy to landing site ellipse
- Errors during descent

He indicated that the prospects for the second mission are not very good and that the C', F and G missions will not change the situation. On C' the interest in navigation during about 5 orbits is for rendezvous rather than landing purposes.

With this to be considered, Jack proceeded with the "good news" starting with the LM descent techniques and the Parameter Time Histories of a nominal descent for both the old two-phase and the new one-phase concepts. He indicated that in the one-phase concept the radar is satisfactorily insensitive to terrain roughness. From his discussion it became apparent that software changes are possible, and when Bob Bryson asked about this, Jack answered positively and went further to say that software changes should be asked for. At this point Don Beattie asked whether there are any terrain constraints for take-off. Jack answered negatively and indicated that in this case the system is orbit sensitive.

Jack Sevier continued the discussion of redesignation and indicated that success of redesignation will depend on:

1. Ability to see the landing site

   - trajectory (and early visibility of landing site)
   - lighting (range 6-12° and optimum 8°)

2. Ability to assess what is seen

   - Astronaut training
   - nature of feature of interest
   - number of options available

3. Performance limits

   - ΔV (present budget 6997 ft/sec ± 119 ft/sec)
   - landing radar
   - visibility limits

III. EARLY APOLLO SITES

Following a brief recess, Newell Trask led the discussion of the early Apollo sites. He explained the geology of each site with emphasis on scientifically important features which may be considered for a relocated site. Each area was considered on its own merits and as part of the lunar exploration plan in general.

The discussions resulted in the following recommendations:*

1. The already established list of 5 prime sites including II P-2, II P-6, II P-8, III P-11 and II P-13 should remain unchanged for the first lunar landing.

2. The matter of introducing I P-1 was brought up again. A discussion followed and it was concluded that I P-1, although a good eastern site, is not now worth the effort. III P-12 (relocated), however, was introduced because of its importance and also because the analysis work on this site is partly completed.

3. There was general agreement among the participants that if the first landing is to be in an eastern mare, the II P-6 site would be preferable. The scientific problems at II P-2 are rather unique to it, and have less application to the lunar surface in general than those at II P-6.

4. For the second mission three relocated sites are desirable; II P-8, III P-11 and III P-12. The previously discussed relocated sites in II P-2, II P-6 and II P-13 are not recommended. Features in these sites are interesting but do not appear to warrant the additional mapping effort of relocated sites. Instead of a relocated site, designation to any predesignated point within the prime ellipse is to be sought for these three sites. This is put forth mainly for operational purposes, i.e., to prepare for pinpoint landing on the third mission (landing points in the relocated sites II P-8, III P-11 and III P-12 have already been identified as shown in Appendix C).

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*See Appendix C for descriptions of both prime and relocated sites as recommended in this meeting.

5. Priorities among the sites for the second lunar landing mission after landing in any given site were considered. The outcome is given here in Table I.

6. In view of their importance, it was also recommended that the U. S. Geological Survey give high priority to the geologic mapping of III P-12 and III P-11. They constitute the only relocated sites which have not yet been mapped.

The session of the first day was concluded with discussions on whether or not Fra Mauro and Hipparchus should be considered as fall-back sites for the second mission. No decision was reached.

IV. THE THIRD MISSION

The session of November 14, 1968 started with a discussion of the candidate sites for the third mission. These include the sites which were selected previously by the Subgroup (see Figure 1) and three additional sites (indicated by parenthesis):

In the Apollo Zone	Outside the Apollo Zone
Censorinus	Hyginus
Mösting C	Tycho rim
Fra Mauro	Littrow
Hipparchus	Gassendi
(Copernicus CD)	(Rima Bode II)
(Gambart)	

A discussion of the geologic, geophysical and geochemical importance of the sites followed. Some technological i.e., operational, aspects were also considered.* The purpose was mainly to assign time-priorities to these sites for purposes of mapping.

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*The following post-meeting remarks concerning operational aspects were communicated by Ilan Silberstein:

"The GLEP selected some candiate 'relocated sites' and 'science sites'. In my opinion, operational aspects were de-emphasized in the selection process. The expectations from the LM guidance and navigation system implied in the selection of the above sites for mapping will not in all probability be fulfilled. Thus, there is a danger that when the improbability of landing near the interesting features becomes clearer, there will not be sufficient time to map more acceptable sites. In particular the navigational accuracy implied in selecting small or north-south features for exploration will probably not be possible in early missions. The emphasis should be on sites where features of interest are dispersed throughout the landing ellipse or on east-west oriented features".

TABLE I

SECOND MISSION PRIORITIES AFTER THE FIRST LANDING

A. CONSIDERING PRIME SITES ONLY

FIRST LANDING:	II P-2	II P-6	II P-8	III P-11	II P-13
II P-2	X	2	2	3	3
II P-6	2	X	-	1	1
II P-8	3	-	X	2	2
III P-11	1b	1b	1b	X	-
II P-13	1a *	1a	1a	-	X

B. CONSIDERING RELOCATED SITES

FIRST LANDING:	II P-2	II P-6	II P-8	III P-11	II P-13
II P-2	X	2	2	3	3
II P-6	2	X	-	1	1
II P-8R	3	-	X	2	2
III P-11R	1b	1b	1b	5	4**
III P-12R	1a	1a	1a	4	5

X INDICATES THAT THE FIRST LANDING IS MADE IN THE CORRESPONDING SITE

- INDICATES THAT THE SITE SHOULD NOT BE CONSIDERED FOR THE SECOND MISSION

R INDICATES A RELOCATED SITE

* BOTH SITES ARE IMPORTANT BUT 1a WOULD HAVE HIGHER PRIORITY

** PRIORITY OF TYCHO'S RAY IS IMPORTANT IN THIS CASE FOR COMPARISON WITH TYPICAL MARE MATERIAL

The discussion resulted in assigning the following priorities based on the scientific merit of the sites:

1a. Censorinus
1b. Tycho rim
2. Rima Bode II
3. Fra Mauro

Because these time-priorities will affect geologic mapping requirements and site analysis studies, it is important to indicate, at this point, why these sites were selected.

Censorinus is the most popular candiate site for the third lunar landing mission. It is a 3.8 km probable impact crater located within, but near the edge of, a highland block S-SE of Mare Tranquillitatis. The proposed landing site is to the north of the crater within the ejecta blanket and about 1 km from the rim (0° 17'S 32° 39'E). The site offers a unique opportunity to sample, early in the lunar exploration plan, both highland material and features associated with a fresh impact crater. Censorinus is large enough to exhibit clear signs of impact, but small enough to be investigated on a foot traverse.

Tycho is also a fresh impact crater, in the highlands. However, it is much larger than Censorinus (about 85 km in diameter) and thus offers an opportunity of studying the many features common to large, fresh impact events, including associated volcanism. The vicinity of the landing site of Surveyor VII (41° 00'S 11° 25'W) is the proposed landing site.* In that area one encounters several generations of flows, a pond or pool, ejected blocks probably from Tycho, other ejecta features and structures, and the Surveyor VII Spacecraft.

Rima Bode II is a single linear rille which runs close to a fresh, elongate crater. Both the rille and the crater are possible sources of a number of dark geologic units most probably of volcanic origin. Therefore, the site (12° 55'N 3° 45'W) was selected as an example of a volcanic region, replacing the previously selected site near Littrow (21° 50'N 28° 55'E).

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*For detailed description see: Geologic characteristics of the nine lunar landing mission sites recommended by the Group for Lunar Exploration Planning, Bellcomm TR-68-340-1, by Farouk El-Baz, May 31, 1968. In this report it is also argued that the Tycho site is a very favorable one from the geophysical standpoint; namely for seismic network construction.

In all previous GLEP sessions, Littrow was considered of high priority in this selection. Rima Bode II was introduced to the list this meeting and somehow replaced Littrow. It is my opinion that this should be reconsidered for the following reasons.

1. The Littrow site is already on the FY-69 list of the GLEP and preparations for its processing as a candidate landing site in the early phase of lunar exploration have already begun.

2. The geologic relationships at Littrow may be simpler than those at Rima Bode II which speaks for the former as a better earlier mission.

3. Most of the scientific objectives of a mission to Littrow may be realized by a walking or Apollo-type mission (without mobility aids). In the case of Rima Bode II this may be questionable for there may be a need for an LFU to reach the floor and walls of either the rille or the crater as well as some of the dark surface units.

4. From the geophysical point of view the position of Littrow is very favorable for net-work triangulation especially because of its proximity to the edge of Mare Serentitatis.

5. Bob Bryson (personal communication) who strongly advocated Rima Bode II at the time of the meeting, is now of the opinion that we may have made a mistake by giving it higher priority than Littrow.

At this time I would like to recommend the replacement of Rima Bode II by Littrow in the time priority list. Don Wilhelms approves of such a change and I would like to hear from all participants about their views concerning this recommendation.

Fra Mauro (3° 45'S 17° 36'W) is a site in the Fra Mauro Formation, an extensive geologic unit covering great portions of the lunar surface around Mare Imbrium. Therefore a mission to this site would result in an understanding of the nature, composition, and origin of this widespread formation. A similar site to that of Fra Mauro Formation, although in somewhat different terrain (the Cayley Formation), would be in Hipparchus.

V. LRV TRAVERSE STUDIES

Don Beattie conveyed to the Subgroup the desire of Benjamin Milwitzky to obtain geologic maps for use in design studies for the development of an LRV as well as for trafficability studies of potential LRV traverses.

Hal Masursky presented a set of possible LRV traverses on the lunar earthside prepared by the "Flagstaff Group on Dual Mode Site Selection". As illustrated in Figure 2, the numbers on a given traverse indicate the following:

1. Landing site of the LRV and the beginning of the traverse.

2. Intermediate point for possible surface rendezvous with a (manned) mission, or an end point of the traverse. If the vehicle is to continue roving, in most cases several possibilities are given for the direction.

3. End point of traverse if it is to be continued beyond the intermediate point.

Hal pointed out the scientific justifications of such traverses and intimated that two of them would provide the best results; the ones starting in eastern Mare Serenitatis, and those which cross Mare Imbrium. This is particularly true because either one of these traverses would provide enough coverage of one of the major maria where sizeable gravity anomalies or "mascons" have been detected.

A discussion of the required mapping for LRV designs and trafficability studies followed. It was agreed that since 1) the USGS man-hours have been pre-empted by maps for candidate sites of the first three missions; and 2) the nature of the vehicle is not quite clear, i.e., its capabilities are not fully understood, the map products already in existence might be sufficient for preliminary studies at this stage. However, it was intimated that if and when a specific requirement for a map at a given scale is needed to impact the design of the flyer or the rover, the question will be brought up again to the Subgroup.

VI. GEOLOGIC MAPPING

A. Apollo Sites

It is now established that the recommended candidate early Apollo sites are as follows:

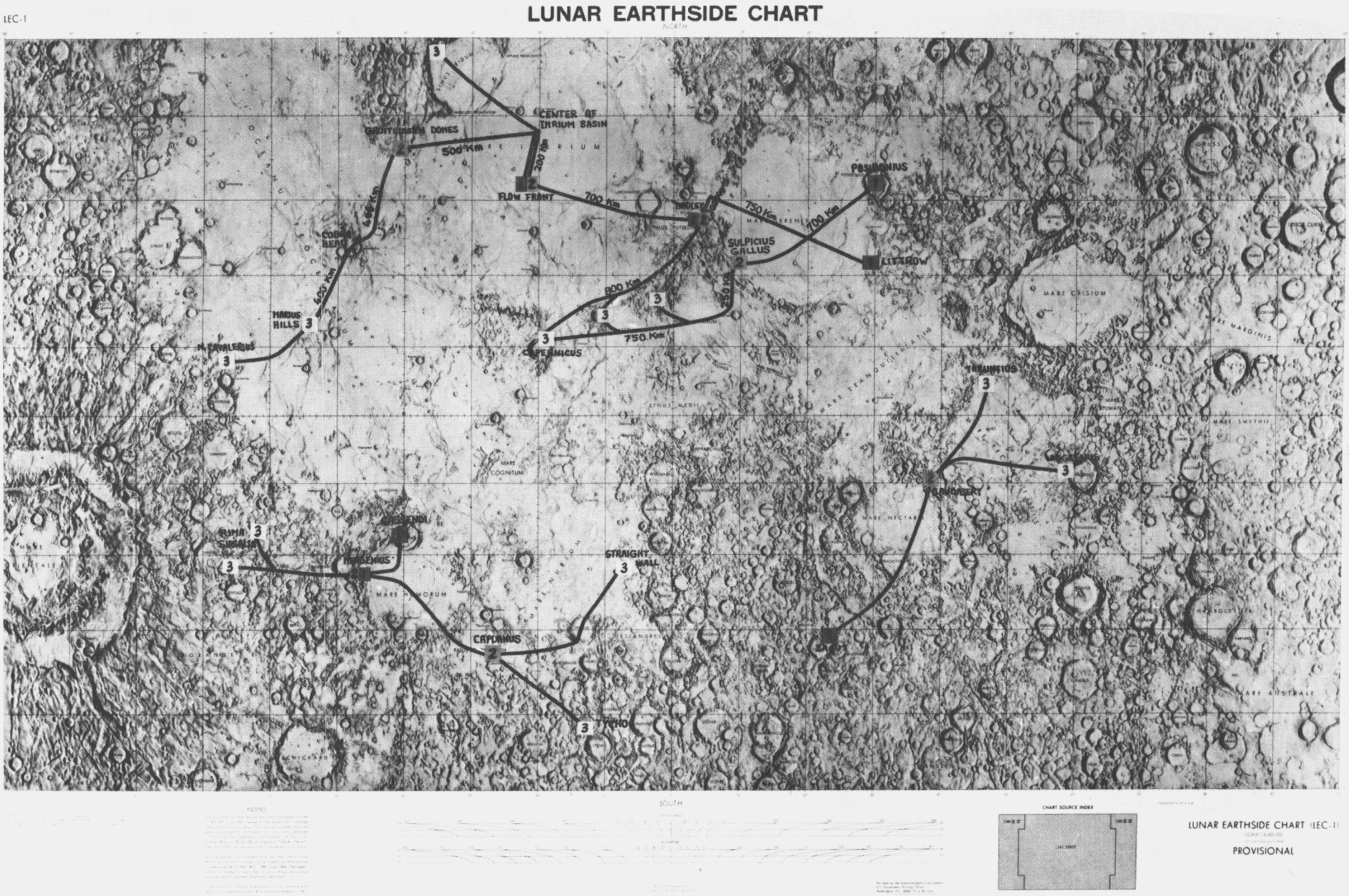

FIGURE 2. POSSIBLE UNMANNED LRV TRAVERSES ON THE LUNAR EARTHSIDE BY THE FLAGSTAFF GROUP ON DUAL MODE SITE SELECTION

First Mission Sites

II P-2, II P-6, II P-8, III P-11 and II P-13 (prime ellipses)

Second Mission Sites

-Designated points within prime ellipses of II P-2 and II P-6

-Relocated sites in II P-8, III P-11 and III P-12

The U. S. Geological Survey has already produced maps, in preliminary form, of the first mission sites at 1:100,000 and 1:25,000. A requirement for 1:5000 maps of the ellipses was set forth (mainly by E. M. Shoemaker) and these five maps have been completed. A map of III P-12 at 1:100,000 has also been produced by the USGS. It follows that the remaining geologic maps of Apollo sites to be executed in FY-69 are:

1:100,000	None
1:25,000	Relocated III P-12
1:5,000	Relocated II P-8, III P-11 and III P-12

B. Third Mission Sites

As indicated earlier the priorities for mapping of candidate sites of the third mission resulted in the selection of the following sites:

1. Censorinus
2. Rima Bode II*
3. Tycho rim
4. Fra Mauro

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*This site is not in the present GLEP list for FY-69 site processing. It is suggested above that it be replaced by the Littrow site, which has long been considered for this mission and offers better scientific opportunities for the early phase of lunar exploration.

When the matter of the scales at which these sites should ultimately be mapped was discussed, it was suggested that the USGS should use the same scales at which Apollo maps were done. Don Wilhelms voiced an objection and indicated that there is no need for maps at three scales: 1:100,000; 1:25,000 and 1:5,000. Two scales should be sufficient, he pleaded! Hal Masursky agreed with some reluctance and suggested 1:50,000 and 1:10,000 for a site such as Censorinus.

A discussion of the usefulness of geologic maps at various scales followed. Factors considered were mission planning, astronaut training, etc., as well as the USGS man-years required. It was decided that the most useful scales would be (1:200,000 or 1:250,000)* and 1:25,000. The latter could be "blown-up" to 1:10,000 if the need arises.

The results of the decision on map scales and the discussions that followed are:

1. The USGS is to produce geologic maps of both Censorinus and Rima Bode II at 1:25,000 in FY-69.

2. 1:250,000 or 1:200,000 of both Censorinus and Rima Bode II should be on the list for FY-70.

3. Completion of the partly finished map of the rim of Tycho (at approximately 1:10,000).

4. Completion of the partly finished map of the Fra Mauro site (at approximately 1:150,000 or 1:100,000).

5. Request the uncontrolled base maps from the DoD for Censorinus, Tycho, and Rima Bode II at 1:250,000 or 1:200,000 and 1:25,000.**

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*Jim Sasser indicated that this is the limit set for topographic mapping and that in some cases the choice will be site-dependent. Bob Bryson voiced his opinion that the uniformity of scale is rather important. The subject was not discussed further, but there was preference for the 1:250,000 scale.

**At the meeting it was also decided to request base maps for the Fra Mauro site at 1:250,000 or 1:200,000 and 1:25,000. However, it was not realized that the ACIC is already producing base maps for this site at 1:100,000 and 1:25,000. Therefore, unless there is a specific requirement for the 1:250,000 (or 1:200,000) map no further action should be taken. Comments are invited.

C. LRV Traverse Sites

Following a discussion of the problems and present requirements, the Subgroup decided that no new maps are necessary, at this time, for LRV design and trafficability studies. It was felt that presently available products such as the 1:1,000,000 and 1:5,000,000 maps and the existing maps of the Marius Hills region, the rim of crater Tycho, etc., should meet the present requirements.

2015-FEB-kse

F. El-Baz

APPENDIX A

LIST OF PARTICIPANTS

Members of Subgroup

D. A. Beattie, NASA HQ/MAL

J. W. Dietrich, MSC/TH2

F. El-Baz, Bellcomm (Secretary)

L. W. Frederick, University of Virginia (Absent)

P. Gast, Lamont Geological Observatory

W. N. Hess, MSC/TA (Absent)

R. L. Kovach, Stanford University

N. W. Hinners, Bellcomm (Chairman)

H. Masursky, U. S. Geological Survey

H. H. Schmitt, MSC/CB (Absent)

G. Simmons, M.I.T. (Absent)

D. Wilhelms, U. S. Geological Survey

Other Participants

R. P. Bryson, NASA HQ/MAL

D. P. Elston, U. S. Geological Survey

J. W. Head, III, Bellcomm

T. N. V. Karlstrom, U. S. Geological Survey

J. P. Loftus, MSC/HA

J. H. Sasser, MSC/TH3

J. R. Sevier, MSC/PD12

W. H. Shirey, NASA HQ/MAL

I. Silberstein, Bellcomm

N. J. Trask, U. S. Geological Survey

APPENDIX B

AGENDA-GLEP SITE SELECTION SUBGROUP

Wednesday, November 13

9:00 A.M.	Introduction and Agenda	N. W. Hinners
9:15	U.S.G.S. Mapping Activities FY '69	D. A. Beattie
9:30	Site Selection Status Current Landing Constraints	J. H. Sasser J. R. Sevier
10:30	Discussions of redesignate and relocates sites. Delineation of science "footprints" New sites. Site nomenclature.	
12:30	Lunch	
1:30	Continuation of above	
3:30	Discussion of "Hess" tentative Set B sites for 3rd landing	
4:00	Review of MSC "rework" of Set B landing points.	

Thursday, November 14

9:00 A.M.	Discussion and selection of unmanned traverse sites and objectives.
10:30	Review of preliminary write-ups on Apollo and subsequent sites.
12:00	End

APPENDIX C

DESCRIPTION OF EARLY APOLLO SITES

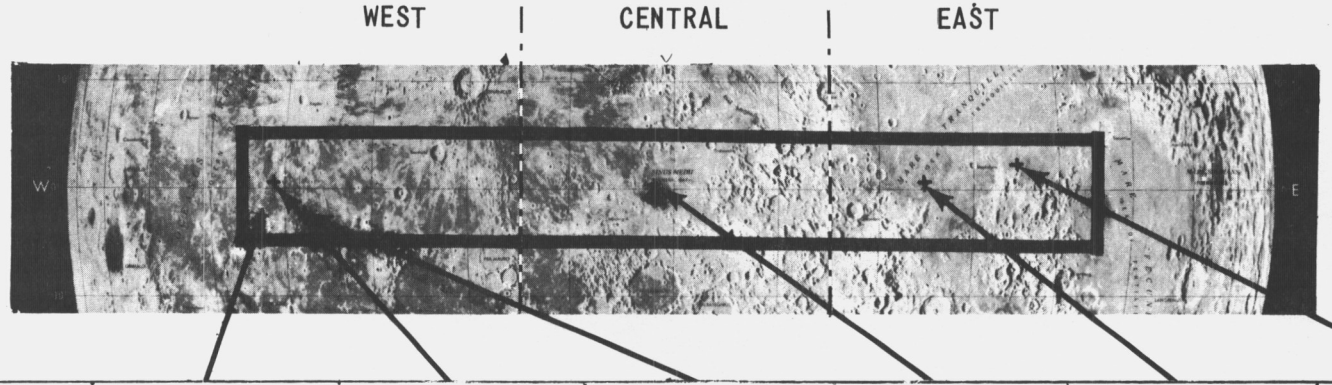
Early Apollc sites may be defined as the candidate landing sites for at least the first two lunar landing missions; they fall within the Apollo Zone and are essentially smooth mare surfaces.

The five first mission "prime sites" are, from east to west, II P-2, II P-6, II P-8, III P-11 and II P-13. One site, III P-12 within the Flamsteed ring, was added to the list for second mission consideration. These sites have been given a designation by letter and number; the letter indicates whether the site is in the east, central or west portion of the Apollo Zone, and the number indicates its sequence in the original site selection process (see Apollo Lunar Landing Site Analysis, a document prepared by MSC, August 1968). Some inconsistancy has been noted in citing this designation. We recommend the use of the Lunar Orbiter site designation and the adherence to the nomenclature given on the next page.

In three cases, namely II P-8, III P-11 and III P-12, "relocated sites" are recommended for the second mission. These include areas which lie totally or partly outside the ellipse of the prime sites. Landing points in "relocated sites" are within walking distance (less than one kilometer) from a prominant feature, such as a ridge. Therefore, and unlike the case of "prime sites", the predesignated landing point is critical in a given "relocated site".

Following the next page, descriptions of all prime and relocated sites are given along with illustrations of each case. The written material was prepared by N. J. Trask, U. S. Geological Survey/Menlo Park.

APOLLO ZONE
(EARLY APOLLO SITES)



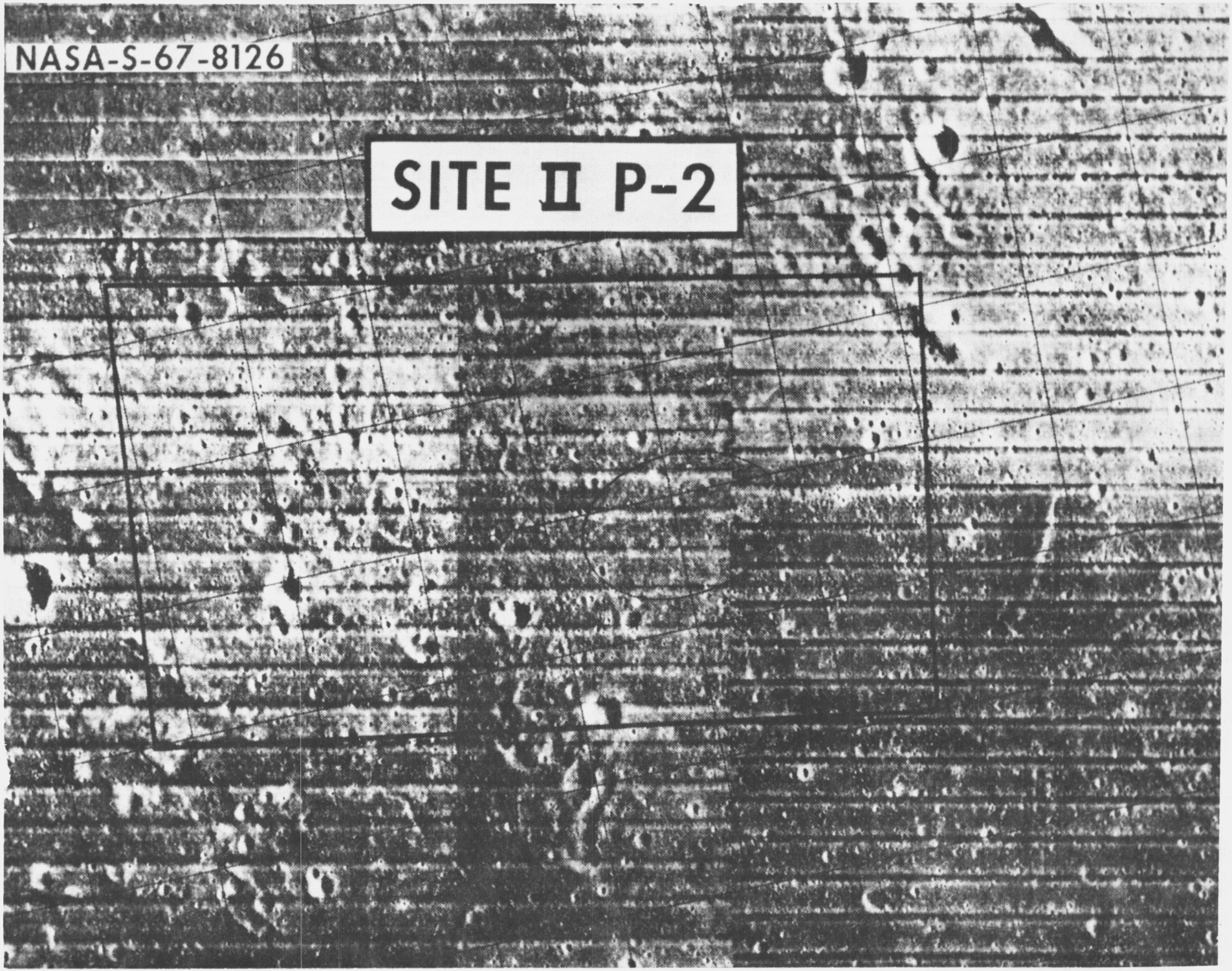
LO SITE*	III P-12**	II P-13	III P-11***	II P-8***	II P-6	II P-2
DESIGNATION:	W3	W1	W2	C1	E1	E2
LONGITUDE:	42:30W	41:40W	36:25W	1:20W	23:37E	34:00E
LATITUDE	2:40S	1:40N	3:30S	0:25N	0:45N	2:40N
LOCATION:	OCEANUS PROCELLARUM			SINUS MEDII	MARE TRANQUILLITATIS	
	FLAMSTEED RING	SOUTHWEST OF KEPLER	NORTHEAST OF WICHMANN R		SOUTH-SOUTHWEST	SOUTH-SOUTHEAST
LAC CHART:	LETRONNE 75	KEPLER 57	LETRONNE 75	MARE VAPORUM 59	JULIUS CAESAR 60	TARUNTIUS 61
AIC CHART:	FLAMSTEED 75A	MAESTLIN 57D	WICHMANN 75B	PALLAS 59D	ARAGO 60C	MASKELYNE D 61D

*THE LUNAR ORBITER SITE DESIGNATION IS RECOMMENDED FOR USE
**A NEW SITE ADDED TO THE FIVE ORIGINAL SITES DURING THIS MEETING
***THE TWO AREAS (II P-8 AND III P-11) INCLUDE RELOCATED SITES

II P-2 (Mare Tranquillitatis, S-SE)
East Two (E2)

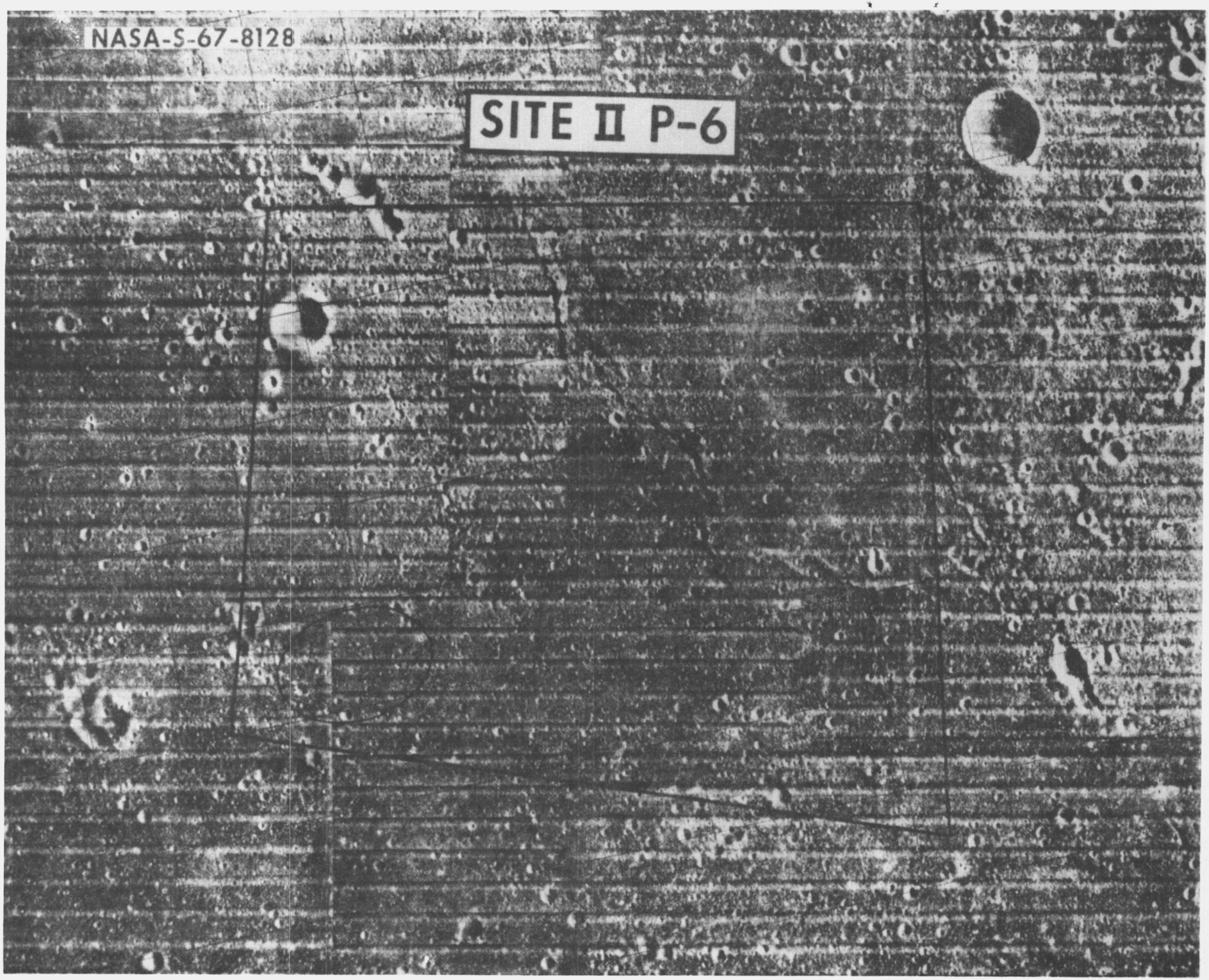
Of the 5 sites, II P-2 (E2) is unique in that a large proportion of it is covered with terra mantling material. The evidence is reasonably clear that this material has progressively covered typical mare material which occurs in only a small portion of the site in the east. The terra material has higher albedo than the adjoining mare material and fewer craters 70 m and more in diameter. The material may be a relatively young volcanic cover; the presence of a mare dome with a cleft of probable volcanic craters along it nearby supports this interpretation. Alternatively the material may be mass wasted debris derived from rugged terra which is also nearby. Determination of the nature and age of the terra mantling material is the main question to be answered by a mission to the site. The anomalous nature of the material, however, introduces new uncertainties into attempts to interpret the results of a mission in terms of fundamental lunar problems and dictates that the site has a low priority on all missions except the first.

The mare material in the site is relatively old (Imbrian); should it be the site of the first landing, the scientific results would be similar to those described for II P-6 (E1) below. Exploration strategy for subsequent missions would be different if the first landing is on mare material in II P-2 (E2) from what it would be should the landing be on the terra mantling material in the same site.


NASA-S-67-8126
SITE II P-2

II P-6 (Mare Tranquillitatis, S-SW)
East One (E1)

This site is located entirely within relatively old (Imbrian) mare material. There are many large subdued craters 200-600 m in diameter; the number of intermediate size craters 50 - 200 m in diameter is fewer than on younger mare material in other sites. This crater distribution is common on many apparently old surfaces including the Imbrian blanket (Fra Mauro Formation). It may reflect a thicker layer of surficial debris in these areas of relatively old terrain so that intermediate size craters have an initially soft appearance and are rapidly destroyed. An alternative explanation is that a mantle of pyroclastics is present; some craters near the site may be volcanic and could be the source of the pyroclastics. Determination of the age and nature of mare material (Imbrian) is the prime object of a landing in this site; determination of whether or not pyroclastics are present will have application to many other areas with similar crater populations.


NASA-S-67-8128
SITE II P-6

II P-8 (Sinus Medii)

Central One (C1)

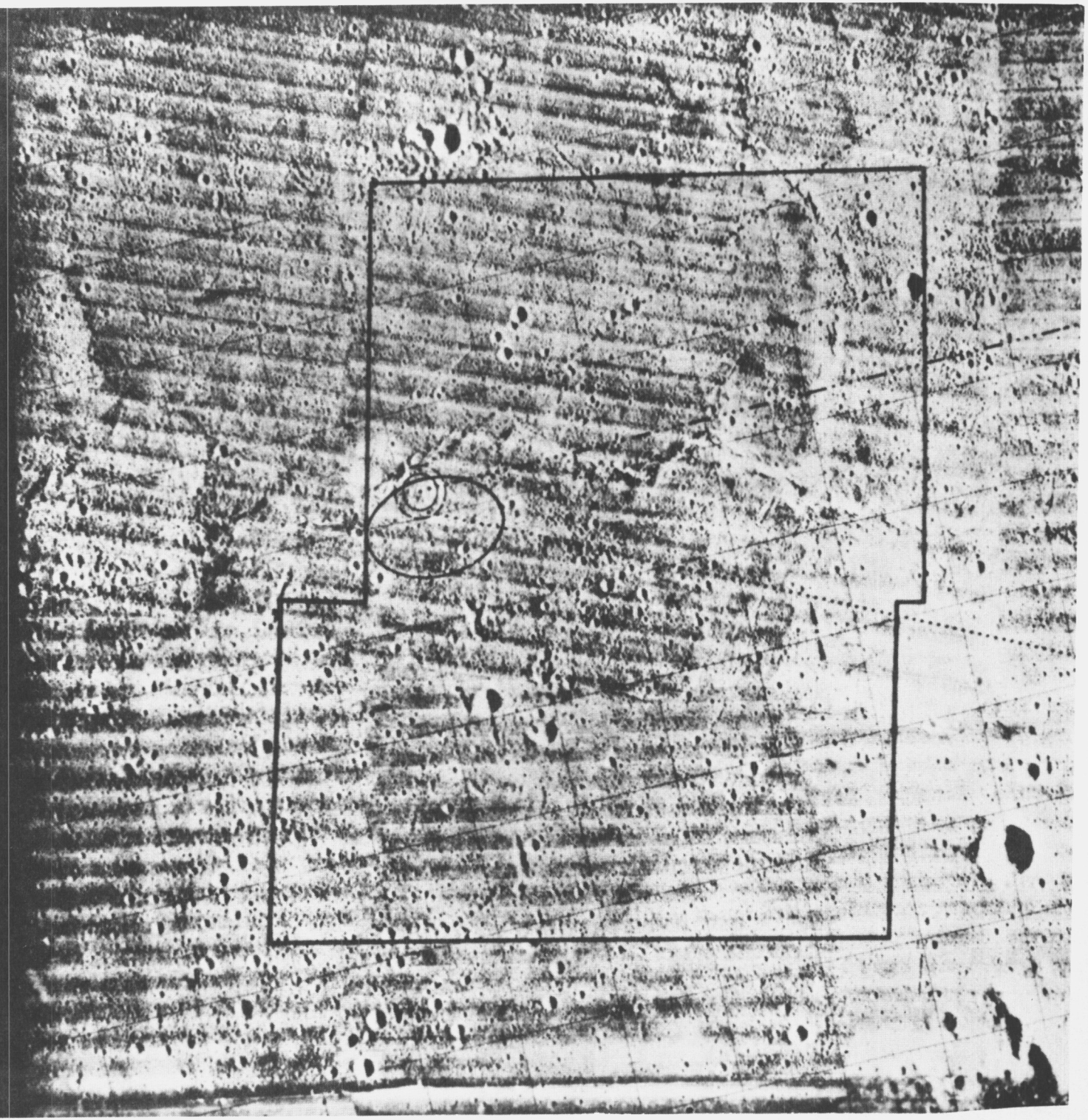
Broadly viewed, this site is in material which appears about as old as that in II P-6 (E1) but may be slightly younger. Ages and compositions are expected to be similar to those of other relatively old mare. A low narrow ridge runs approximately east-west in the eastern end of the (C1) ellipse. In the western part, a poorly defined contact separates an area in which the craters are slightly fewer and generally more subdued than to the east. Material west of the contact may contain a component of relatively young pyroclastics. Fundamental science at this site is similar to that at II P-6 (E1).

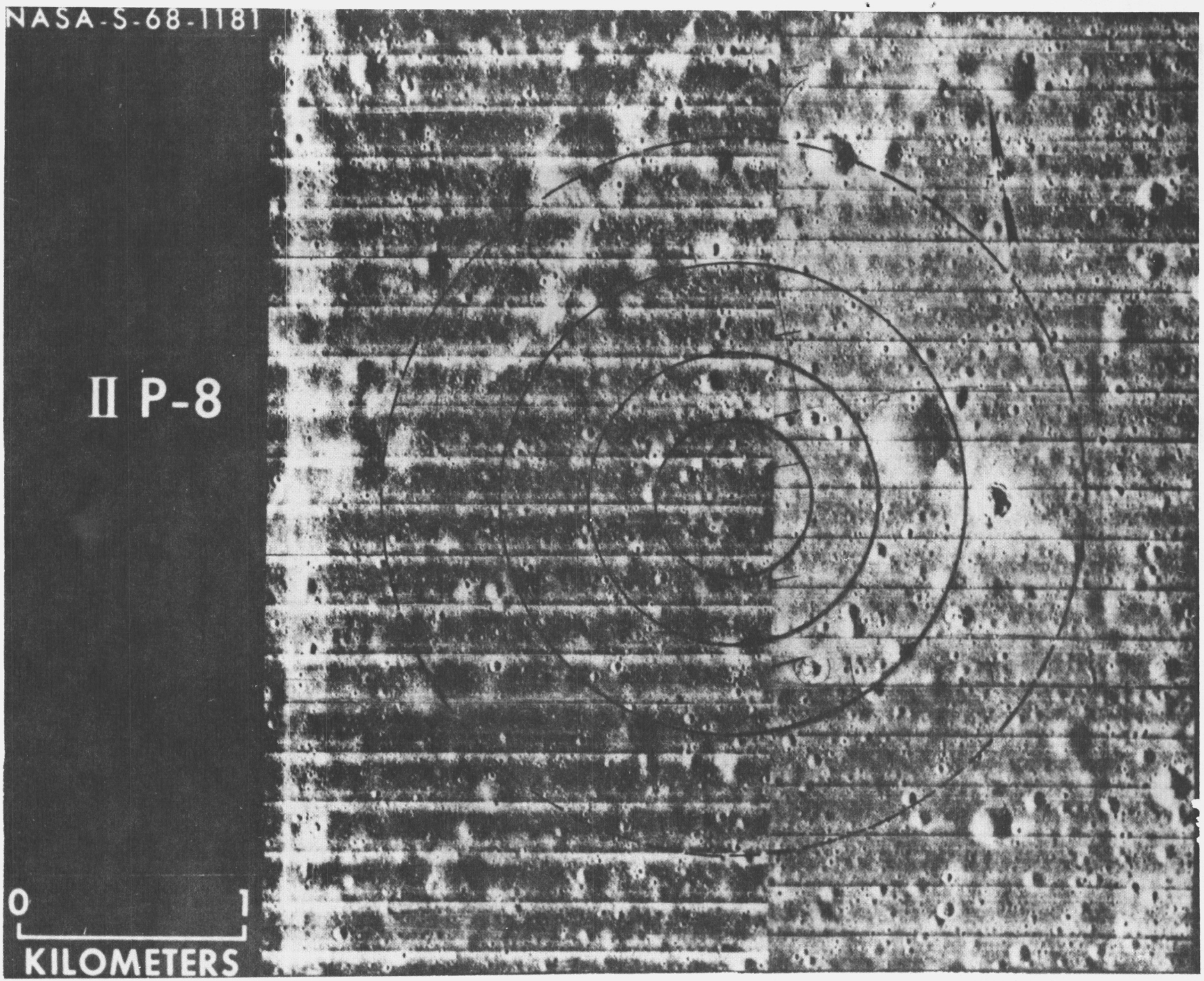
Relocated II P-8

The relocated landing site is on the south edge of a prominent, zigzag mare wrinkle ridge. The nominal landing point is in old (Imbrian) mare material. A one kilometer traverse from the landing point reaches a well-defined terrace at the contact between the ridge and the mare material. The convex upward terrace is similar to many others on the Moon at the base of steep slopes.

NASA-S-68-831

II P-8




NASA-S-68-1181
II P-8
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III P-11

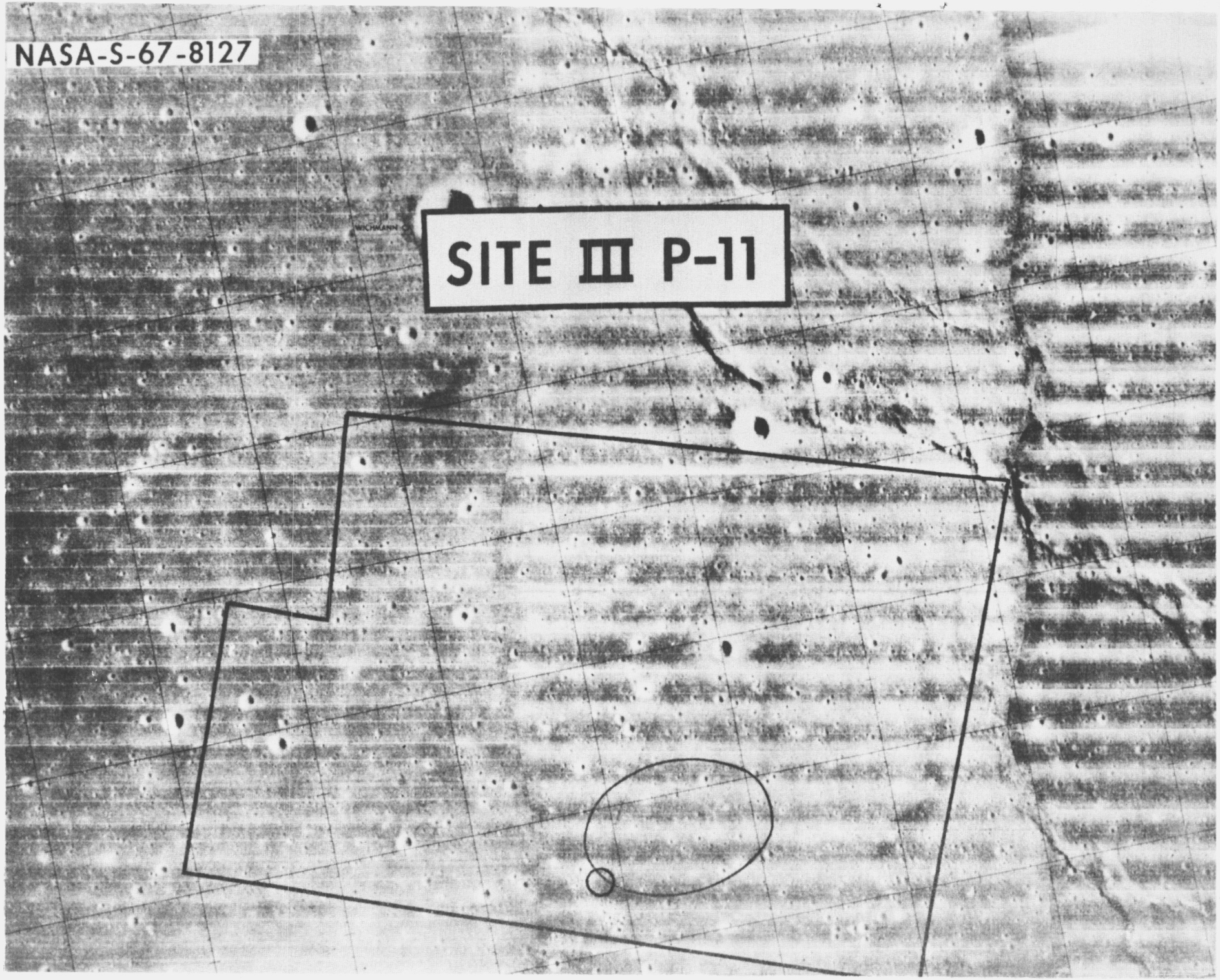
(Oceanus Procellarum; Northeast of Wichmann R)

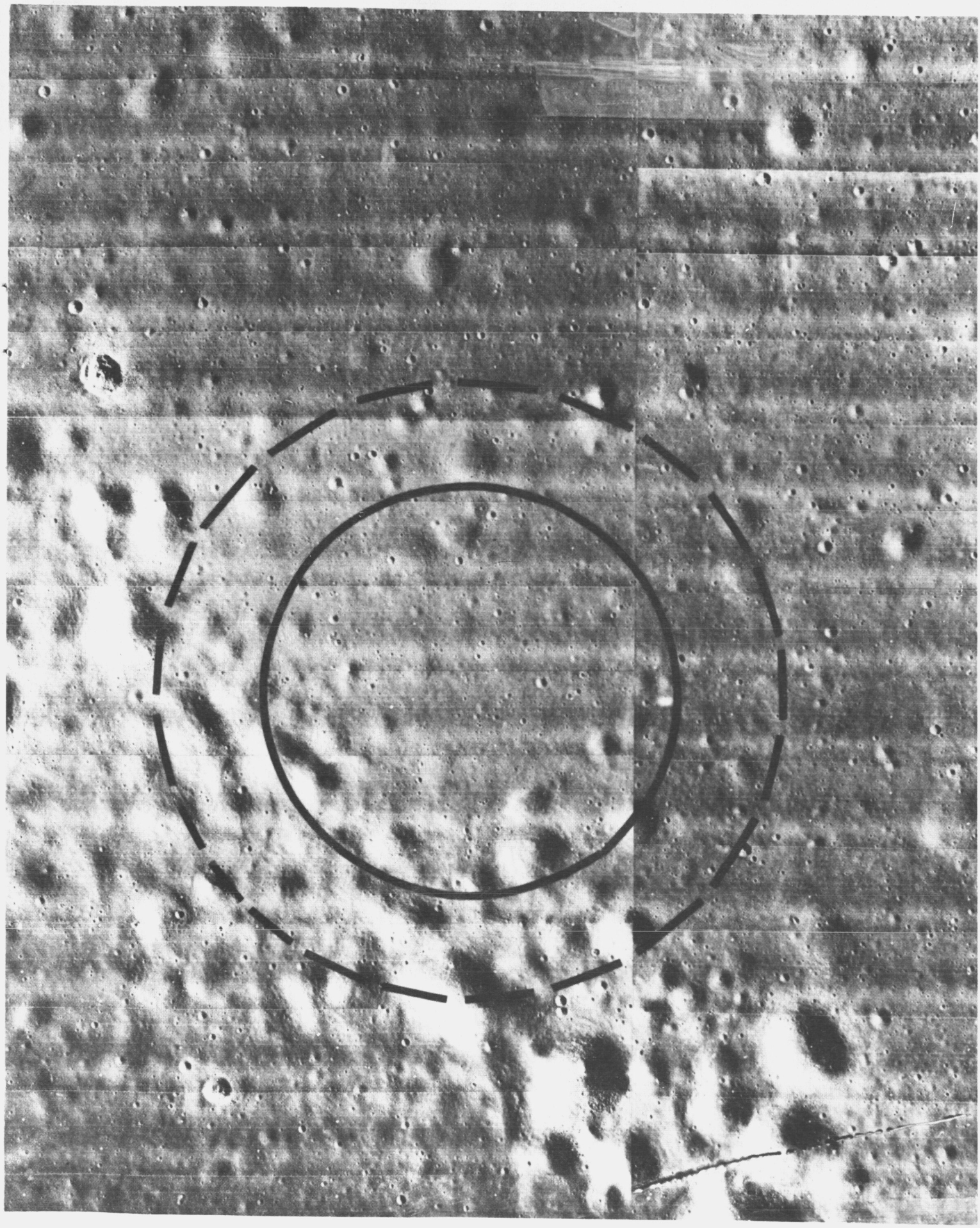
West Two (W2)

This site is located in relatively young (Eratosthenian) mare material. There is an abundance of resolvable blocks around craters indicating relatively coarse-grained surficial material. Other indications of relative youth are the presence of numerous poorly-defined to well-defined sinuous scarps suggestive of flow fronts and a widespread texture of low hummocks and hollows 5 to 10 meters across suggestive of an original volcanic topography. The fragmental layer is thinner here than in the other four sites according to the criteria of Quaide and Oberbeck. A Tycho ray cluster crosses the site at its west end. Near the center is a well-defined scarp, in which mare stratigraphy may be apparent, and a relatively youthful flow which forms the unit at the top of the scarp along part of its length. The main information to be gained from a landing is the age and composition of the Eratosthenian mare material. In this site, details of the mechanisms of mare emplacement may be better shown than in others because of the relatively fresh appearance of the material and the thin layer of surficial material.

Relocated III P-11

The relocated landing site is near the east edge of a northwest trending Tycho ray cluster. The nominal landing point is in typical Eratosthenian mare material. A one kilometer traverse from the landing point reaches the northeast margin of the cluster. Resolvable blocks are abundant in and around the cluster. Regardless of whether or not the blocks are from Tycho, chances are good that highland material derived from Tycho may be found in the surficial material at the cluster. It may be possible to fix the age of the Tycho impact event.


NASA-S-67-8127
SITE III P-11

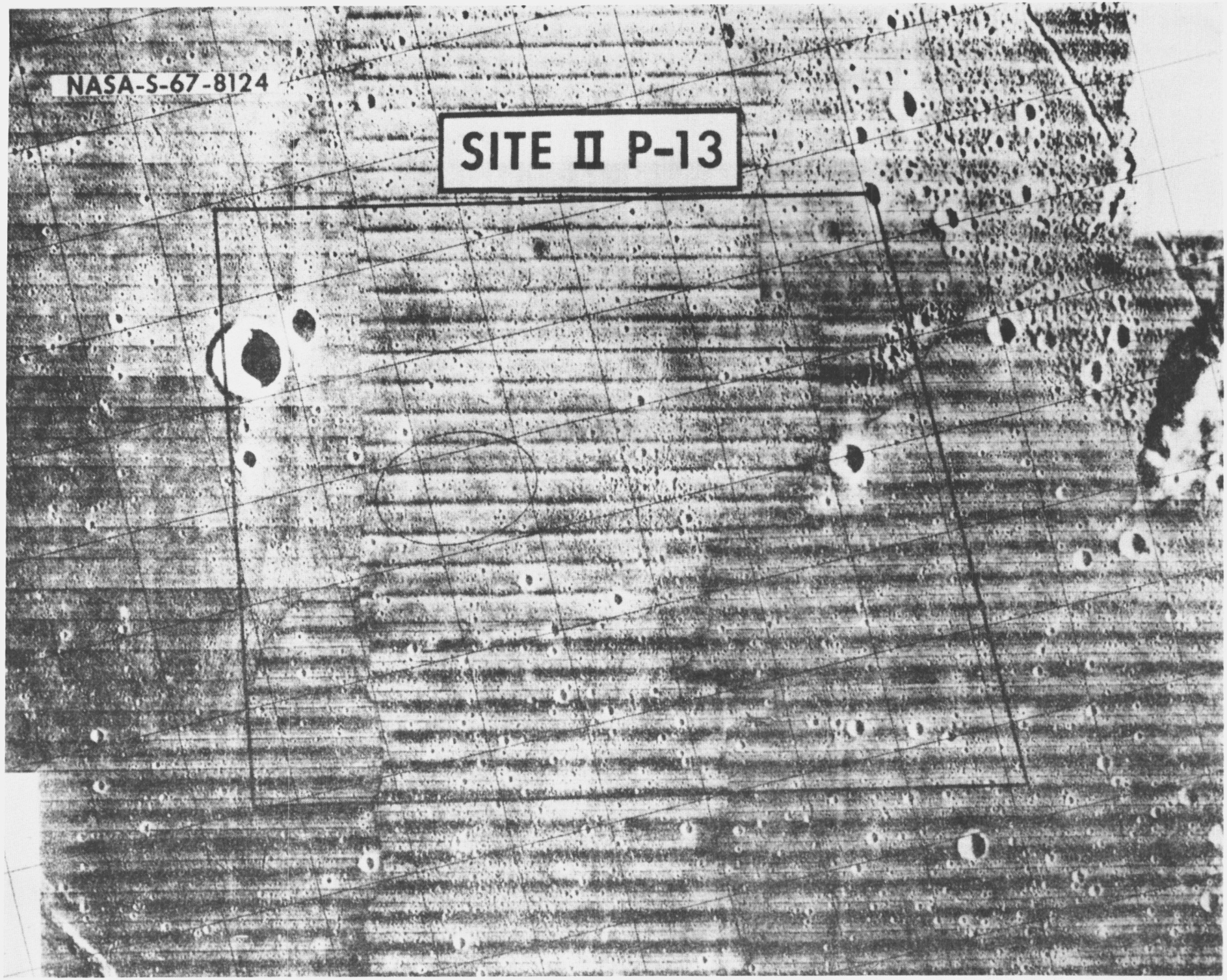


II P-13

(Oceanus Procellarum; Southwest of Kepler)

West One (W1)

This site (W1) is entirely within relatively young (Eratosthenian) mare material. There are more resolvable blocks (> 2m) around craters than in the three sites to the east suggesting that the surficial material is generally coarser grained. The site is surrounded by well-developed ray clusters of the system around Kepler. Small, weakly-developed crater clusters and lineaments radial to Kepler occur within the site. Thus some material derived from depth at Kepler may be present in the surficial material and fine-scale textural details related to the Kepler rays may also be present. The chief goal of a landing in the site is determination of the age and composition of the Eratosthenian mare material.


NASA-S-67-8124
SITE II P-13

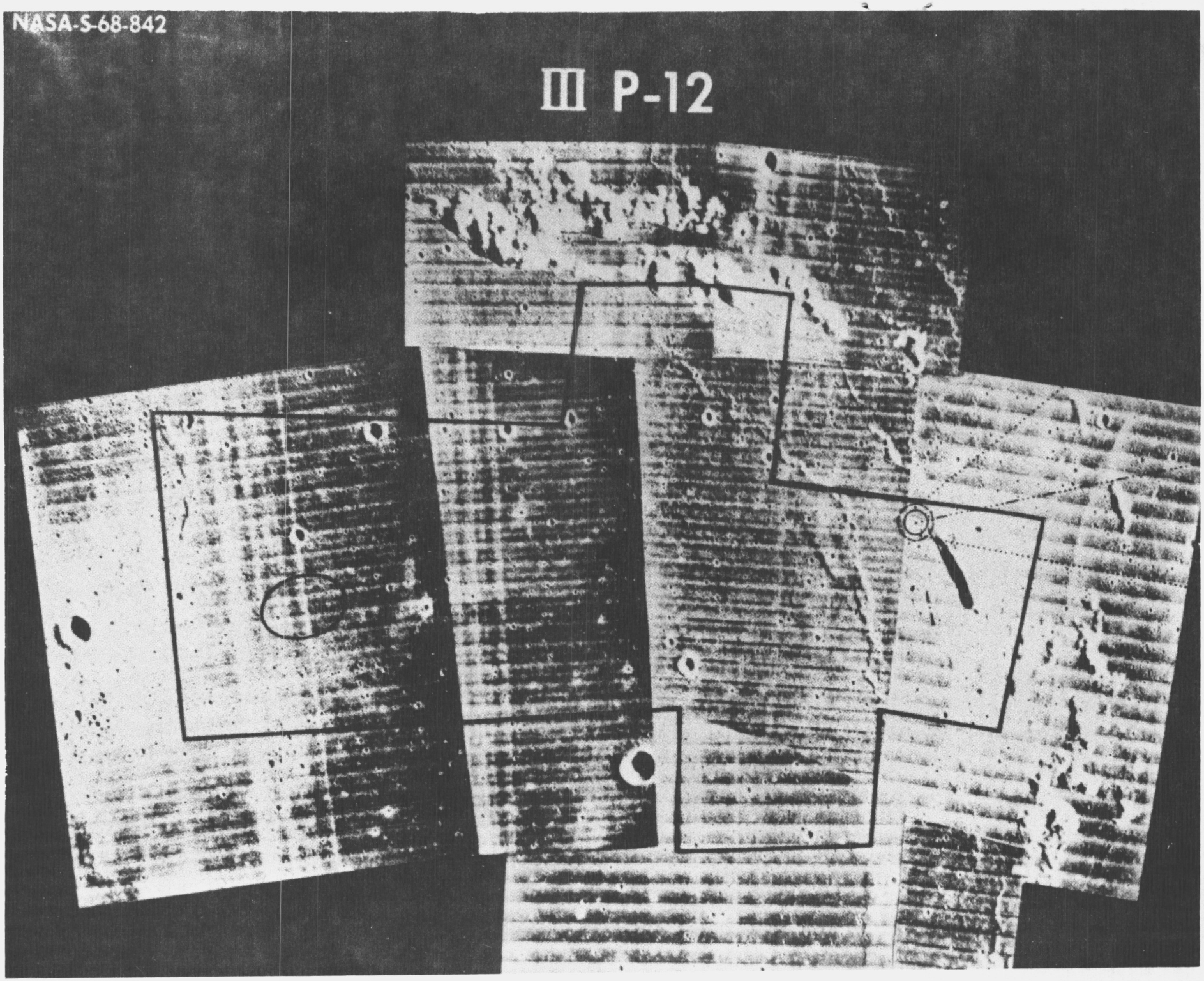
III P-12

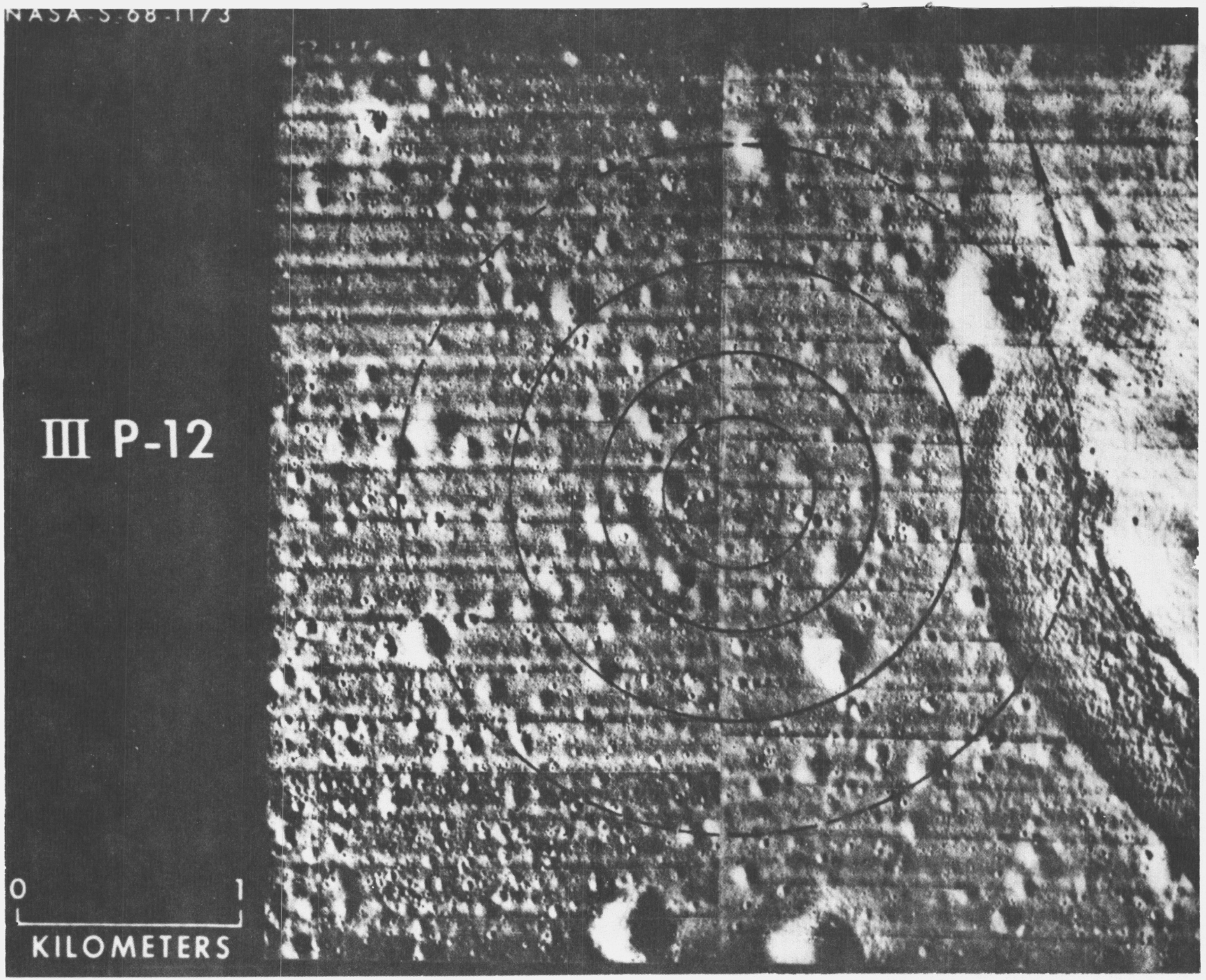
Flamsteed P (Flamsteed ring)

West Three (W3)

This is essentially a new landing site on relatively young (Eratosthenian) mare material inside the Flamsteed ring. The nominal landing point is on the mare and a 1 kilometer traverse reaches the convex-upward terrace at the foot of a relatively steep west-facing slope on the east side of the ring. Blocks up to 10 m across are present on the slope and at its top. The ring has been interpreted as the remnants of an old eroded and flooded crater, a young caldera-like structure still in the process of developing, or even a ring-dike. The surficial layer is relatively thin over most of the mare material and resolvable blocks are common around craters. Several scarps suggestive of flow fronts are present. An anomalous unit of very smooth mare material with well-developed patterned ground occurs north and west of the landing point. It may consist of volcanic materials still younger than the Eratosthenian mare which occupies most of the site. Determination of the age and composition of the Eratosthenian mare material and the age, composition and possibly origin of the Flamsteed ring are the goals of a landing at this point.

NASA-S-68-842




NASA-S-68-1173
III P-12
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Third Meeting - November, 1968

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